

Satellite may herald era of space observatories

The complex astronomical satellite which helped British university researchers pinpoint the strongest black hole candidate yet detected could be the forerunner of a series of space observatories in orbit by the end of the next decade.

And Peter Sanford, of London University College's Mullard space laboratory, said he expected major astronomical observations to be conducted from space telescopes by 1990.

"People will regard earth-based astronomy in the same way as the world of string in a telescope in a swamp," he added.

His comments were made following the announcement of the success of a UK team, working in conjunction with American researchers, in detecting a potential black hole in orbit about a giant star in the constellation Scorpio. The discovery was made last month with instruments on the American satellite

Compton.

Using an X-ray telescope, placed on the satellite, the Mullard team's suggestion, the group has deduced that the giant star's companion must be a collapsed star. Their calculations indicate that this is so massive that it must be a black hole, an object so dense that even light cannot escape from its gravitational field.

The first black hole candidate discovered in our galaxy, known as

Cygnus X-1, is regarded with scepticism by some scientists. "The discovery of a potential black hole is therefore highly significant," Mr Sanford added.

But the existence of these objects raised problems of philosophical importance. Just as the universe started with the big bang, so the end of stars in quasi-stellar black holes was equally absurd, he believed.

And Mr Sanford stressed that X-ray astronomy would grow rapidly in importance over the next ten years. "It will be matched by optical astronomy in stature. However, we have got to increase the sensitivity of our observations, then the number of sources in the galaxy will rise tremendously," he said.

He believed the subject was particularly important because it dealt with very energetic stellar sources. "Fortunately, the Science Research Council rates X-ray astronomy very highly, although we always have to consider the most cost-effective method of putting instruments in orbit."

Mr Sanford added that by the time X-ray astronomy had reached the same importance as optical astronomy, most telescopes that were being developed would be for space observatories where the effects of the Earth's atmosphere would not interfere with observations.

Wave testing unit opens

A £100,000 wave-testing tank, which can reproduce all possible sea conditions, was opened this week at Edinburgh University. The unit, financed by the Department of Energy, was designed by a wave power research team led by Stephen Salter of the mechanical engineering department, and will be used in experiments on generating electricity from sea waves.

A computer is used to control the tank's 80 separate wave-makers and this will allow far greater accuracy in the collection of data from experiments. Mr Salter said several other groups concerned with wave research had indicated they would copy the design of the tank in future and he added that they would also be making the unit available to the National Engineering Laboratory and various universities.

The tank will be used to find the most cost-effective construction of "moulding blocks", the floating, pear-shaped bodies, designed by the team, which can convert wave power into controllable energy.

"We know how to make these units but we have to find the cheapest way of constructing them to high enough strengths," Mr Salter said.

It was vital to build them strongly because of the "terrifying" power of waves, he added. And it is expected that the first floating power station, consisting of a 30-kilometre string of about 1,500 "ducks", will come into operation by about 1985, although it would not be possible to produce electricity commercially until 1990.

A 30-kilometre station would produce about 1,000 megawatts of electricity, Mr Salter estimated, the equivalent output of an average power station today. However, wave power would cost about twice the price of electricity today. "The usefulness of wave-generated electricity really depends on how much oil is liable to cost in the 1990s," he added.

Unusual degrees

Two unusual research degree courses in archaeology with an emphasis on method and science are to be offered by Southampton University this autumn.

The MA course in archaeological method, which is unique by the university, will focus on the rapidly developing fields of quantitative methods in archaeology. This will include computer applications and the use of explicitly theoretical models.

The aim of the MSc course is to give instruction in the technical research methods widely used in archaeology today. This will be both in the field of artifact analysis (centring on petrological study and trace element analysis) and environmental archaeology (with particular attention to faunal remains and prehistoric geology).

Look at firms graduate needs

The graduate requirements of small firms in manufacturing industry are to be examined in a six-month research project carried out at Reading and Manchester and funded by the Department of Industry.

The work will be carried out by Mr Roger Brown, assistant careers master at Reading University, and supervised by Mr Brian Pate, director of the Central Services Unit, at Manchester, an umbrella organization which covers all the advisory services for polytechnics and universities in the country.

Mr Brown will limit his study to the South-East region but Mr Pate will keep a "running book" of the situation to ensure that the work does not reflect any idiosyncrasy because of particular circumstances in that part of the country.

Mr Pate said this week: "Obviously we hope this kind of exercise will help us to stimulate the market and increase the range of graduate opportunities. Many of these firms could extend their use of graduates."

Both the Departments of Industry and Education have in the past been critical of the lack of knowledge about industrial employment processes. As part of the research project, small firms with a good record in employing graduates will be asked what factors govern their choice.

Firms which do not usually go into the graduate market will be asked to say what they are looking for in a prospective employee. First year students will also be asked for their views on their attitude towards small firms. The research grant is £30,000.

Acid environment

Bacteria survival in an acid environment is the theme of new research being undertaken at Aberdeen University by Dr W. A. Hamilton of the department of microbiology, with funds from the Science Research Council.

A search for more efficient methods of assessing candidates in the Certificate of Secondary Education is under way in Leicester University's school of education.

The East Midlands Regional Examinations Board has awarded a research grant of £44,000 to re-think the rapid increase in the number of candidates sitting CSE examinations. But the board expects a return on its investment in the shape of recommendations for the cheaper assessment techniques.

Since the introduction of CSE in the mid-1960s, the number of candidates has risen from less than half the age group to the point where

Over-16s project in job blackspots

Four areas with high youth unemployment will be the basis for major research into long term curricular alternatives for the over-16s.

The project, being undertaken by Youthaid, will look at the London Borough of Brent, Cornwall, Liverpool and Rotherham. It has been commissioned by the Further Education Curriculum Review and Development Unit.

The aim is to work on the form and content of a curriculum to provide for the wide ranging needs and interests of young people after school.

In particular, it will examine how far the further education service can help them meet the demands of regular job changes and gain the skills necessary. It will see how far the service of learning activities with periods of employment and helps make creative use of leisure time.

Commenting on the programme, Mr David Logan, Youthaid's director, said: "At a time when the

Windscale waste to be studied by scientists

Scientists at Lancaster University have been given a £40,000 grant to examine what happens to radioactive materials carried in effluent from the nuclear plant at Windscale.

The grant has been given to the Department of Environmental Sciences by the Natural Environment Research Council.

Dr Simon Aston, director of the research, said this week that the project was designed to find out how low concentrations of artificial radionuclides moved through the natural environment, and was not intended as a monitoring exercise on contamination levels or hazards to public health.

The study will examine how environmental processes govern the passage and behaviour of radionuclides in the soil, streams, rivers, estuaries and coastal areas. At the same time radionuclides in the environment will act as tracers which will reveal more information about the natural pathways and processes themselves.

The research team will also examine what happens to radionuclides distributed in the environment from natural sources and through fallout.

Researchers from five countries have carried out 800 interviews throughout Europe to gauge the performance of British firms in foreign markets.

The study, financed by a £30,000 grant from the Social Science Research Council, is in the hands of Dr David Ford, of Bath University, and Mr Malcolm Cunningham and Mr Peter Thornhill, of the University of Manchester Institute of Science and Technology. All three also have experience in industrial marketing and have been working on the project for 18 months.

They have found that different sectors of British industry approach international marketing and selling in widely different ways. Too many firms have been found to suffer from the "English disease" of poor quality and unreliability, with the result that many still lag behind the field in export markets.

Although forward-looking companies have restructured their marketing operations to adopt to

education service is increasingly being asked to make more provision for young people, particularly those in the 16-19 age group, the question of what courses are most attractive and appropriate is beginning to assume great importance.

It will see how the courses could be linked to the social and economic needs of a diverse group of young people, many of whom had not gained full advantage from their schooling.

"Not only must the content of the courses be relevant to the development of the student, but the teaching and learning methods must be appropriate for young people who are seeking to establish their adult status," said Mr Logan.

Consequently, Youthaid will be looking for new approaches towards the location of learning activities and the role which the wider community can play in supporting the learning process.

The project will look at the social and educational needs and interests of young people and the existing range of educational, leisure and vocational provision for them.

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The initial three year project will involve comprehensive studies of the coastal and inland areas of Lancashire and Cumbria, including the Lake District.

Former president of the National Union of Students, Miss Sue Slipman, has been appointed full-time inquiry officer for a research project being undertaken by the Advisory Council for Adult and Continuing Education.

A committee of the council, headed by Mr Peter Kline, has been set up to advise on the project. The committee will be making recommendations to the advisory council at the end of the year. It is hoped a report on the research project will be available early in 1979.

To aid the project, the advisory council is seeking information and comments from existing guidance and counselling services and organizations contemplating the establishment of such groups. It is also anxious to hear from clients who have used guidance services. The council is based at 105 De Montfort Street, Leicester LE1 7GE.

A new treatment of anemia, anemia, cardiac diseases and other ailments may result from work being carried out at Aberdeen University on the design of drugs capable of controlling the amount of oxygen in the blood.

Scottish Endonorms Research Trust have given around £17,000 to Dr La Folgarait in the department of biochemistry to support a year project; this will involve determination of the key enzyme structure which regulates the binding of oxygen to hemoglobin.

Proposals have been made to replace both CSE and O levels with a single "16 plus" examination, but it is hoped that the proposal will be relevant to any new system. Mr Ramsden said a new examination could not be introduced until 1985 at the earliest and there had been a tendency to defer looking at problems in the meantime.

Dr Elaine Freedman is to take up a post of research fellow in September, undertaking the study with the assistance of two research students funded by the Social Science Research Council. The project will be under the joint direction of Professor Gerald Bernbaum and Mr Ramsden will only be chosen after close consultation with the examining board.

D. J. Ramsden, the board's secretary, said a number of prob-

The team will also examine how it might be integrated in a range of activities to promote the development of young people. It might be developed by the new curriculum options based on further education.

Experiments on these new curriculum options will be carried out with the teaching and learning methods necessary to give young people worthwhile education.

"This will lead to an examination on the best methods of the curriculum planning and the principles involved in curriculum construction."

The report will make recommendations about the development of policies at institutional, local, Governmental levels, necessary to young people to get the best from the provision.

The first report, available after five months, will outline the nature and scope of the problem and a detailed account of how the areas looked at are dealing with it. The final report will be at the end of 1979.

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giff based on the belief that undergraduate education is a long-term investment whose major costs should not be borne by the state, nor by students' families, but should be repaid by the graduates themselves out of their higher lifetime earnings.

On as Congressman Michael Harrington puts it: "Since college education generally brings financial benefits beyond the human enrichment which they afford, a student ought to be able to mortgage a fraction of that anticipated income to finance his education."

Dr Silber's TAF plan was recently introduced in a bill in the House of Representatives by Mr Harrington and in the Senate by Edward Kennedy and John Kennedy. This is how it works:

The federal government would create an educational fund from which any undergraduate who had successfully completed his or her freshman year could draw up to \$5,000 a year in paying tuition fees and up to \$1,000 of other educational expenses. There would be no means test.

After graduation, the student would repay his advance at an annual rate of 2 per cent of his gross income. Instead of paying interest, each recipient would pay back a fixed 50 per cent "surcharge" in addition to the original advance—this would be roughly equivalent to a 2 per cent interest rate if repayment took 20 years.

The Internal Revenue Service would collect TAF repayments at 2 per cent rate along with income tax. Graduates would not wipe out their TAF obligations by going bankrupt in the way some do with conventional loans. Indeed, supporters of TAF argue that there would be virtually no possibility of default.

Repayment times would, of course, vary greatly with the size of the advance and the recipient's earnings after graduation. But in an article explaining TAF in the July Atlantic Monthly magazine, Dr Silber calculates that in a typical case—a graduate with an advance of \$5,000 to finance three undergraduate years, who went on to a reasonable middle class job—that is about half the time it would take to repay a \$6,000 loan with 7 per cent interest at the same annual rate.

Students would be built into the system to prevent individuals from taking unfair advantage of the plan. For example, colleges would have to certify that the recipient of TAF could not be repaid faster than the rate of inflation.

Dr Silber estimates that the cost of TAF to the federal government is likely to be around \$1,000 million a year, against which \$1,500 million would be saved by the reduction in demand for the

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Radical plan for loans to undergraduates

from Clive Cookson

WASHINGTON

There are two main contenders in this year's fierce political battle over the best way to help students finance their college education: the federal administration's plan to expand existing federal loan and grant programmes, and the "Tuition Tax Advance" (TAF) plan.

However, a third, more radical idea is now beginning to gather support. Known as the Tuition Advance Fund (TAF), it was developed by Boston University president John Silber from proposals dating back several decades.

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Colleges for minorities to be audited

America's private black colleges, many of which rely on federal government funds for half their income, have reacted anxiously to reports that the Department of Health, Education and Welfare is planning to cut its support for them.

HEW secretary Joseph Califano has initiated a review of the so-called "programme for strengthening developing institutions"—part of the 1965 Higher Education Act—through which the government channels \$120m a year in grants to colleges with a high proportion of minority or low income students.

Of the 279 aided last year, 44 per cent were mainly black, 8 per cent American Indian and 6 per cent Hispanic.

Mr Califano indicated at a recent press conference that he wants to find out whether the programme, which is due for renewal by Congress next year, is working in the best interests of the colleges and the students.

It is worried that not many of the participating institutions are using federal funds to cover operating expenses and retain in existence, rather than to build themselves up as intended.

At the same time, Mr Califano went out of his way to deny rumours that HEW is planning to cut off these funds to struggling black colleges. But many of them are going to be audited.

The HEW secretary said his objective is to make them into "viable" institutions—a statement which prompted the Washington Post's well-known black columnist William Raspberry to write: "Califano and his staff are unfamiliar with the historical role of these colleges, unaware of the fact that they have never been audited."

Because these colleges serve a poor and disadvantaged student body, they cannot charge high tuition fees. They might help them maintain their standards.

Two private black colleges, Shaw University, in North Carolina, and Bishop College, in Texas, are in particular trouble at the moment.

The government says Bishop owes HEW a large refund of student aid funds which the college overdrawn in previous years (80 per cent of Bishop students are poor enough to qualify for federal financial help). Meanwhile both institutions are faced with huge deficits for the current fiscal year.

For, whereas tuition tax credits and the administration's middle-income Student Assistance Bill would give middle-class students at most a few hundred dollars a year, HEW would advance them enough to cover all costs at most universities. The annual cost of undergraduate education next year is expected to be \$3,000 at state universities and \$5,000 at private institutions.

With less than 40 legislative days left before this session of Congress ends in October, TAF supporters do not think there is likely to be time to get their bills through this time round. Their hopes are centred on next year when much higher education legislation is due for renewal.

The best chance of TAF being enacted would be for the Senate to pass a Tuition Tax Credit Act, as the House already has (HRES, June 6 1978) and the measure to be vetoed by the president, as Mr Carter has promised.

Then, if tax credit supporters fail to get the two-thirds majority of Congress needed to overcome a presidential veto, they may well turn to TAF.

The White House is beginning to show serious interest in TAF and Stuart Eizenstat, the President's chief domestic adviser, has been briefed on the proposals by Mr Harrington's staff.

But officials in the Department of Health, Education and Welfare are thought to be unenthusiastic and to prefer continued expansion of their existing student aid programmes.



The Supreme Court: four more decisions

Race judgments calm civil rights fears

from our correspondent

WASHINGTON

The Supreme Court has significantly strengthened support for affirmative action in its complex Bakke decision, appearing to give, in a series of rulings about other reverse discrimination lawsuits.

Ordering Mr Bakke into medical school, the court struck down the quota-based admissions process at the University of California, Davis, while stating that race can be taken into account if it is not the sole factor by which applicants are selected.

The narrowness of the 5-4 majority on which these rulings rested—and the complexities of the justices' written opinions—left considerable uncertainty about the standing of programmes that set numerical targets for women and minorities in fields other than university admissions, notably in employment.

However, a week after Bakke and on the final day of its 1977-78 term, the Supreme Court announced four more decisions about affirmative action, which reassured civil rights leaders who feared that Mr Bakke's victory might herald a new era.

The most important of these post-Bakke actions was to uphold the ban on the American Telephone and Telegraph Company's controversial programme to hire and promote more blacks and women.

AT&T, the biggest company in the world, introduced its affirmative action programme in 1971 under a consent decree that put an end to years of litigation involving several federal agencies.

The company agreed to set numerical goals for women and racial minorities and to pass over white males for promotion in order to achieve them.

But three white males who did not take part in the agreement sued to block it, charging that it illegally destroyed some of the

seniority rights they had won through collective bargaining. A federal Appeals Court rejected the white males' case, saying the programme "seems reasonably calculated to counteract the detrimental effects of a particularly identifiable pattern of discrimination based on race." The Supreme Court took the same line.

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Court ruling could cost £190m

from our correspondent

MILAN — A sentence by a Rome labour magistrate this month could force Italy's universities and schools to pay out hundreds of millions of pounds to tens of thousands of unemployed teachers.

The magistrate ruled that Rome University must pay 20 million lire (about £1,100) to three unemployed university teachers. The teachers, known as *precari*, were employed by the university as untrained assistants and received a salary of only about £140 a month.

The court ruled that because they were expected to teach a full-time load, with the responsibility of examining their students, the university must pay them adequately and provide for superannuation.

About 45,000 *precari* are currently employed in Italian universities. Until now they have been officially classified as research assistants or post-graduate scholarship students.

Other more senior *precari* have achieved a state of semi-tenure and are qualified as "stabilized" temporaries, but enjoy none of the superannuation, seniority rights or other

benefits granted to the few thousand university teachers with full tenure.

The court justified its ruling by stating that the situation of the three unemployed teachers "is no different to that of thousands of other graduates who, through their work, allow the Italian universities to continue functioning."

It is estimated that if the ruling is eventually applied to all the 45,000 unemployed teachers, the state will be forced to pay out at least 200 thousand million lire (about £120 million pounds).

Rome University will almost certainly appeal, but if the Appeal Court recognizes the rights of the three Rome teachers (as seems likely) the ruling will have effect on a national scale. Such a sentence would almost certainly lead to a similar ruling for the thousands of temporaries now working in Italian schools.

Though a fifth of Italy's almost 800,000 school-teachers still technically lack full tenure, recent union/government agreements have guaranteed full tenure to most of them in the near future.

Political unrest threat to campus development

by Dilip Hirani

North Yemen has the inevitable distinction of seeing two heads of state assassinated in less than a year. The recent murder of President Ahmed Hishim Al Ghassani was as mysterious as the violent death of his predecessor, President Ibrahim Al Hamuli, in October, 1977.

President Al Ghassani was allegedly killed by a bomb, hand-dropped by a briefcase carried by a special South Yemeni envoy who had come to see him. The briefcase was reportedly found in the family "rest house" on the outskirts of Sana'a, the capital, along with those of his brother and two French women.

Many people saw, in the official version of the event, a deliberate attempt to tarnish the image of Al Hamuli, a family man of impeccable moral standing, who had been elected when it was later discovered that Al Hamuli was a member of North Yemen's underground Marxist movement, and often presided over clandestine meetings of the Marxist students of the University of Sana'a.

The country's only university has large faculties of arts, and commerce and economics; between them, they account for half of its 3,600 students. It also has many non-Yemenis on its teaching staff, the Yemenis forming no more than 8 per cent of the total.

The foreign teachers, who come from ten different countries, are heavily concentrated in the faculty of science (taught in English), and the English department. But the English teachers, forming 70 per cent of all the faculty, are spread out in Islamic law to the arts. Close contacts with Egypt date back to 1958, when North Yemen joined the Union of Arab States with Egypt and Syria.

The government also started sending students to universities in Egypt, Syria and Iraq, as well as the Soviet Union and the United States. The result is that all the country's institutions are heavily populated by foreign education and/or training.

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Al Ghassani: killed by bomb

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CEDAR has risen from the ashes of the national programme

Computer assisted learning is alive and well at Imperial

Fears that the demise of the £5 million National Development Programme in Computer Assisted Learning last December would lead to a death of new computer-assisted learning projects have been lessened by the successful institutionalization of Imperial College's CEDAR project after six months.

It is both a victory for the organisers of the project and for the philosophy that NIDPAL, an acronym for National Institute for Development in Learning, has instilled in its five year life. This was that each computer based learning project should obtain matched funding from individual institutions and be totally incorporated in the discipline whether science or arts oriented.

CEDAR—Computers as a Resource in Education—was the idea of Dr Edward James, the educational consultant at Imperial College's Computer Centre, who is currently research fellow in educational technology with a brief to investigate the value of CAL in the college. He felt strongly that the incentives provided by the national programme should not be lost.

As a result Mr Nick Rushby, former project coordinator of the computer managed learning part of the NIDPAL project for one year, has been appointed to direct the CEDAR project for one year initially with funds of about £100,000-£150,000. Now that it has been institutionalized, the Computer Centre, Mr Rushby has taken on the additional role of head of applications programme in the centre which will from September have overall responsibility for CEDAR.

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and gaining acceptance of computer in education. He firmly believes that computers are but one of the many educational resources available—teachers rank among the others.

But he points out that computers must be exploited realistically as in many other areas they are the wrong tools. For example, he says, they are totally useless in the case of working training schemes where you have to say, six students learning different practical skills. Another area is teaching foreign languages, where the computer is not sufficiently adaptive and cannot accept information in coded text form.

The CEDAR project is divided into three main areas. An extremely important part is demonstration of what computers can achieve in teaching. This is designed to attract academics' interest and show them exactly what material is available in their own discipline. The next step is to get hold of the computer packages together with the educational material which accompanies them. Where possible the project tries to use existing material, although it does not discourage individual development.

There are now more than 30 teachers at Imperial using computer assisted learning for undergraduate teaching in three major areas. This is a major in mechanical engineering developed under the aegis of NIDPAL. CAL is being used in batch mode for teaching heat flow dynamics. Similar work is taking place in electrical engineering where CAL is being used in an electromagnetism project.

In addition activities in implementing CAL in chemistry for use in chemistry courses at Imperial is to go ahead in small groups in September. This involves importing material from the CALCHEM project.

Mr Rushby is convinced that much could be gained from putting present informal contacts on a more formal basis. He believes that an FEC project should be mounted to freshen up and coordinate developments and speed up collaboration.

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It has been established that much of the large scale computer based learning in the Soviet Union is directed towards the regional centralization of education and its integration within regional planning, and in response to pressures outside the educational system.

There are indications that CBI is being used as a means of delivering or supporting centrally produced curriculum materials in widely dispersed institutions and in distance teaching. Computers are also being used in the management of learning and in educational administration notably in the Ukraine.

Recent contacts with academics at the Moscow Institute, an institution similar to Imperial College, show that some major developments are afoot in line with a statement made in May by Mr Brezhnev that the quality of education must be improved. This was translated as a need to increase the use of educational technology on a vast scale. Therefore a study of educational computing in the Soviet Union promises to hold real benefit for the college and also for the UK CAL community.

Mr Rushby believes that CEDAR has even in this short time done much to promote educational computing generally. He would like this to be expanded to a much greater extent but any further development will require outside funds. If these were forthcoming then a much better service could be provided for the entire CAL community.

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Clifford Healey (left) and Francis Evans suggest how to promote better understanding of engineering

Proficiency in language basic need

Some time ago Dr George Tulley outlined some of the grave defects in engineering degree courses. These he identified in the following way: courses were overburdened with outdated facts and theories; they were remote from the technological, social and intellectual problems of production, and they lacked credibility as general education. He also noted that as specific training for a specific career, more recently we have learnt that industry requires generalists, not specialists, that we should educate engineers for uncertainty and that an engineering degree "should be looked upon as a valuable launching pad for occupations other than engineering".

There is little doubt in my own mind, as a teacher of engineering students, that there is a great amount of truth in these views. The professional debate centres around change in engineering courses. The Chilvers committee recommended that more attention should be given by universities and polytechnics to improving the art and practice of communication.

It is here in many instances that engineering degree courses lack credibility. This is one of the major areas for future concern. Education should be seen as a "leading out" which places an emphasis on communication as an essential part of an educated person's equipment for life and it is vitally important for the future of the engineering profession in Britain that engineers are given a greater degree of training in their native language than is the case at present.

Many otherwise competent engineering undergraduates are greatly handicapped by their fundamental inability to master even the rudiments of the English language. Students who in short time will become professional engineers, possibly fill future managerial positions, cannot sort out differences in tense, use idiomatic expressions correctly, and must serious of all from an employer's point of view, cannot spell the most elementary of words. It is crucial that an emphasis on language, which is so far visualized, will need to be placed on this aspect of an engineer's education.

Engineers themselves are often lukewarm about the benefits conferred by literacy, seeing it as something they did not feel comfortable with at school, or in higher education as something peripheral to the main task of acquiring a skill which will equip them for their future career. This is an attitude which goes symptomatically with the most engineering degrees where there is little time to cram in more than two hours a week of putting right linguistic weaknesses "built-in" throughout a school career.

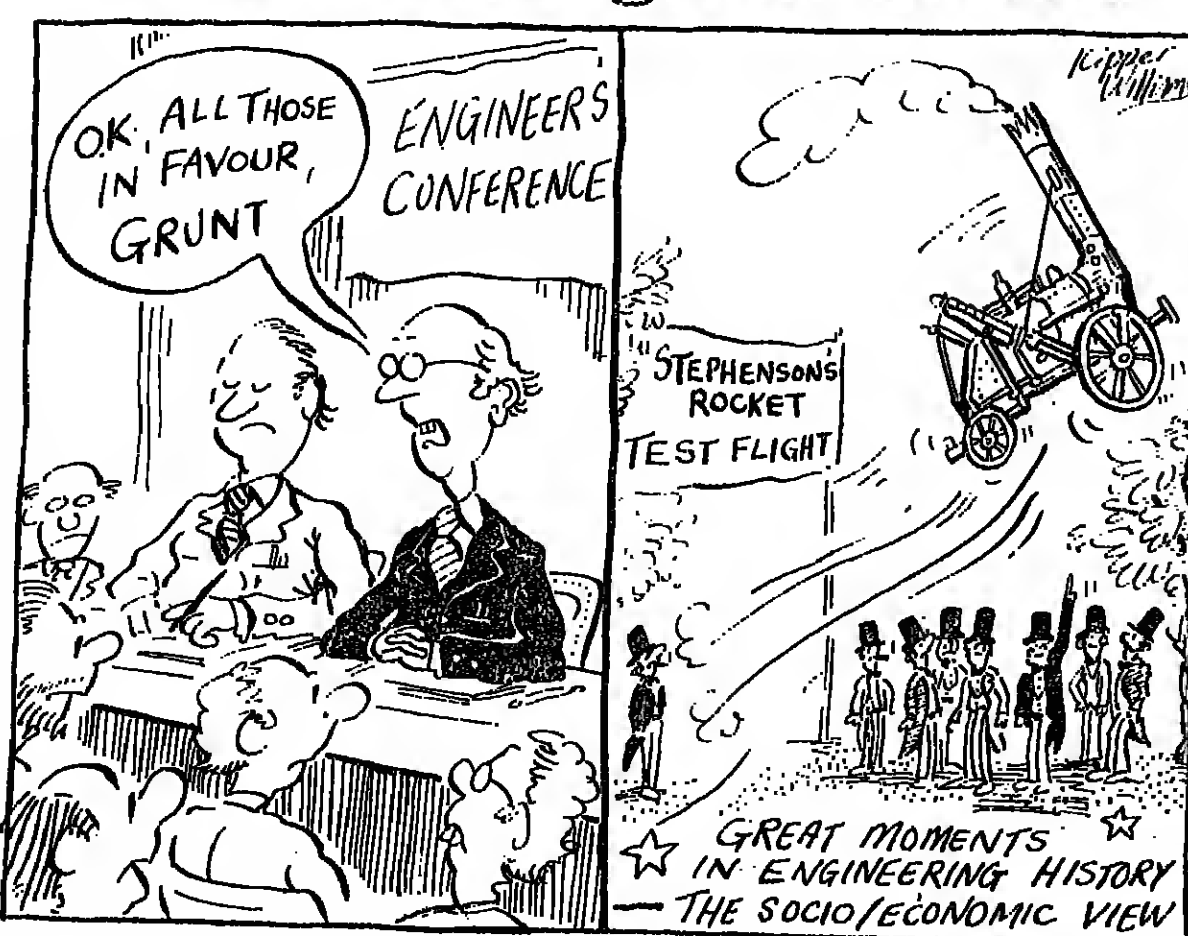
But this attitude, which many vocational students have towards language, is in itself a symptom of the way in which engineers see themselves and reflects the narrow notion of specific training referred to by Dr Tulley. Is it any wonder that such courses should lack credibility as general education?

It is certainly an attitude which misses the vital point that language itself is not something outside the main engineering subjects, but is intrinsically a vocational asset of paramount importance. Language is our most human characteristic and it is understanding of it which gives us the need to communicate ideas in a clear and concise manner so that others can understand what is being said, is fundamental to the notion of higher learning as a whole.

For engineers it is an important aspect of their training in language that they learn how to write a technical report, how to speak clearly and to the point in public or at committees and how to formulate their ideas on chosen topics. But this aspect of language is insufficient in itself for general educational purposes. It remains solidly rooted in the tradition that relevant instruction must be vocational.

Moreover, it is primarily methodological practice in the construction

Across the great divide



of reports is important, but nevertheless insufficient. It will not make the student sensitive to the nuances of language nor will it alter radically his inability to express himself in written or oral work. There are, however, areas of general study which will improve the student's grasp of language which embody ideas and stimulate imagination, but it is not enough to argue, as many engineers do, that all the student needs to know is how to write a technical report.

Peter Abbs, in his recent book, *Rhetoric and the Philosophy of English Teaching*, argues the case for a view of language which places the person at the centre and views it as something which flows from a person's whole make-up and character. And while in Abbs's book this idea is related specifically to schoolchildren, it is also applicable at higher levels of education. It is sensitivity to language which makes and which must be cultivated and that can only be the fruit of a serious involvement in human studies.

Students of engineering and other vocational subjects need to broaden their knowledge of other areas of life and learning and there is an urgent need for members of professional engineering bodies to encourage it. Engineers are people and they need to understand the side of themselves as much as they understand their vocational role.

Max Black has made the point in *Science, the Humanities and the Technological Threat*, that "science... has only a limited and partial educational value because, in its search for objectivity, it is committed to suspending certain distasteful human interests and preoccupations". This also applies to the world of technology and in the language of technical writing which is precise and factual and leaves out the world of the language of the self which is based upon feeling.

Black characterizes this objectivity as the "language of science". We use the language of the self that science cannot encompass, "to express in multifarious ways, feelings, attitudes, intentions, fears, aspirations, the whole gamut of the so-called 'non-cognitive' uses of language".

Lip service is often paid to the notion of liberal education within the engineering curricula, but as becoming increasingly unrecognizable. Vocationally orientated disciplines are seeking to narrow the gap between them from liberal education so that many teachers of arts subjects are being pushed into absurd aerobics in an endeavour to find a correlative relevance for their fields of study. This means

once again compliance with a narrow and unconvincing notion of relevance. I have seen Council for Academic Awards submissions which talk about literature that will place the main emphasis on an engineering content which in reality is not present in the work. In fact it is debatable whether there are any literary works which are emphatically "about" engineering.

There is talk of "types of structure", the phrase used unthinkingly by a choral of relevance in an engineer's mind. There is certainly an architecture of literary narrative, but it is not a structure of blocks and mortar like a building. The humanities are concerned with human relevance and if they do not succeed in this sphere they do not do so totally. It is merely perverse to expect from a discipline more than it can give simply for the sake of fitting into a vocational framework. It is in the long run vitally important to see that we do not slip into the error of assuming that technology will solve all our problems, to see on the other hand that we do need to help students become aware and sensitive to the human side of the need help in the personal area as well as they need instruction in factual knowledge.

This will not be achieved with more personal study time, or cramming in more vocational skills, but by broadening courses sufficiently to give students the necessary insight and ability to anticipate prejudice and provide them with a mature judgment in values. In practice this will involve a greater degree of training in linguistic and oral skills within a flexible range of courses which broaden their minds in a general way.

We must strive to guard against the situation described by Lewis Mumford as a "bias against the personal" in western society, where human values, purposes and ideals have lost credibility in the emphasis which has been placed upon the physical, biological and technological sciences. In the summary of this "bias" provided by Titus Mautner in his book *Living Issues in Philosophy* we can visualize the dangers inherent in too narrow a vocational perspective.

"Science has tended to reject the unique, the non-repeatable. This neglect of the inner life explains in considerable part the lack of confidence, the confusion, and the loss of sense of direction that afflict civilization. Many men now appear to be the victim of their own instruments. We are discovering, however, that we cannot achieve fulfilment or even satisfaction by neglecting the human element."

The author is lecturer in charge of English at Dundee College of Technology.

Outsiders must make effort, too

The debate on the poor performance of British industry has begun to identify a weakness in engineering as one of the main causes. Whatever may be said about economic or social factors, such as investment or labour relations, there remains a substantial crimp which can only be explained by British failure to produce goods which people want to buy. Marketing and labour problems alone do not explain the near death of the British motor cycle industry, or the domination of the home market by foreign slide producers, sewing machines and other small modern consumer goods.

Efforts are being made to raise the standards of engineering education and to tempt a better quality of entrant, but this is merely a partial solution. Until the education and training of non-engineers changes, we shall not have a situation in which good engineering can play a part.

In Britain, the problem is an old one. The powerful engineers—Watts, the Stephansons, Brunels and Parsons—have become rarer, and power has increasingly come to lie with economists, marketing men, accountants and "Managers". Engineers, innocently, have accepted these changes and have done their best to meet them half way by including financial and managerial courses in their syllabuses.

Yet where do we find the accountancy, economic or social studies courses which contain a genuine attempt to explain the basic elements of engineering? As an historian who went on to tinker with the history of engineering, I am continually dismayed at the failure of non-engineers to grasp anything of the fundamental nature of engineering thought. The gap is so wide that non-engineers that here is an area of thought which is vital but which they do not begin to comprehend.

In part, no doubt, the problem lies with the nature of engineering itself. It takes place in the real world, not

a laboratory, and the public does not like a brilliant idea which cannot be made to work. Engineers, like scientists, find that experience is more valuable than theory and that far problems need being a quick, not an ideal, solution. The best thing is "to suck it and see".

Again, engineering lacks some of the beautiful clarity of much science. It is a single problem. For many, science, like economics and other highly rational subjects, is very explicit. The arguments are written down, and they tend to serve themselves to academic study. It would be harder to say exactly why the Spitfire or Volkswagen were designed as they were.

In part, too, engineering is poorly served by its popularizers. The public at large is not familiar with clearly written technical writing, and expositions like D. S. L. Cardwell or the late T. T. C. B. are rare.

Whatever the difficulties, a serious gap exists in the education of many of our professions. People can study modern history and in James Watt actually did to steam engine. They can learn about the American system of manufacture, and yet never see why the internal combustion engine revolution itself to personal transport. And least of all do they have any conception of the need for the revolution which has led from Babbage's mechanical computer, through the old-fashioned valve to the modern microcircuit which can process any information that can be measured, and therefore, in an automatic way, control any process we choose to define.

We easily ignore this whole category of thinking because our normal system excludes it. It is natural in our present way of thinking, for instance, to doubt the political relationship between Churchill and Tizard while radar was being developed. Yet the fundamental question, surely, is whether alternatives, like sound locators or standing patterns of aircraft could not be used as radar aid; and one simple technology is needed to direct this.

Another example is the case of the car. The usual attitude is that they could well and that it is the car which is the problem. The truth is that the car is very technically inadequate in ways that require an engineering explanation. When it is seen that the car is a very poor vehicle, it is not surprising that it is being replaced by a more successful, or when it is less informative, though successful, it is replaced by a more informative and equally successful one.

Information increases with explanatory potential, and is increased by mathematical improbability. The importance of providing a better appreciation of engineering does not stem simply from the weakness of British manufacturing. It extends, also, to the future changes which will come from the exhaustion of some raw materials and energy sources, and which will come with the application of new techniques—the fashionable example is microprocessors. It will be a difficult task to establish a proper understanding of the nature of engineering thought and practice in an intellectual environment where assumptions are predominantly biased in favour of the economic and social, and against anything but a secondary role for the engineer.

It is most important, however, that this gap should be filled by teaching which emphasizes the nature of engineering itself and does not use the opportunity for further emphasizing the social and economic causes in change. These are already well provided for elsewhere, and all too often the attempt to discuss engineering slip into anti-technological or ideological attacks on our social institutions. At the highest level, neither engineering nor any other field of knowledge is autonomous: they intersect. But at the level of the pressing needs described in this paper, engineering must be allowed to stand by itself.

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Is Popper more relevant than Bacon for scientists?

L. Jonathan Cohen calls for a return to Aristotelian values

Certain sections of the scientific hierarchy in contemporary Britain are sometimes critical for being more interested in advancing the frontiers of human knowledge than in developing techniques to exploit the fundamental knowledge that we already have. For example, they want more and more special atom-smashers, yet are not so far from the same as the medical research community pay for it?

On the force of such criticisms, it is difficult to assess. Those who claim that a breakthrough at the fundamental level might turn out to have, at some stage, an immensely valuable technological spin-off; and indeed this might even be true. According to find out whether we have to look at present-day philosophies rather than at the shining-mirrors about priorities. We have to look not at what scientists actually do but at their present conceptions about the nature of science.

Of course, very many (perhaps most) scientists are uninterested in the philosophy of science. But among those British scientists who are interested in philosophy is more widely read or respected today than Sir Karl Popper.

How then does a Popperian scientist conceive scientific inquiry? For him it is a process whereby hypotheses are conjectured to solve problems and are then tested as strictly as possible. If progress is achieved when a hypothesis, that cannot stand up to its tests is replaced by one that is less informative but more successful, or when a less informative, though successful, hypothesis is replaced by a more informative and equally successful one.

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The bubble—the more improbable—the hypothesis that survives its tests, the greater its scientific value. There is therefore no role in science, the Popperians say, for attempts to assess evidential support for a hypothesis, and no need for philosophers of science to construct an inductive logic that articulates normative principles for such attempts. There a hypothesis has been proposed, Popperian scientists seek only to falsify it or to measure its informativeness, not to measure the evidential justification for thinking it true.

The Popperian view provokes a very simple question: what, then, is the point of science? What justifies its pursuit? Why should the community pay for it?

Francis Bacon thought that the proper aim of scientific research was a "new power over Nature". He consciously rejected Aristotle's conception of theoretical enquiry as something that was self-justifying, and the great seventeenth-century British scientists took their cue from him. In striking contrast, Popper's view of science seems to represent a return to Aristotelian values. Popperian science, with its pursuit of unfalsified informativeness, treats intellectual satisfaction as its sole goal.

And there is an intimate link here between value-system and epistemology. Bacon tried to construct an inductive logic whereby scientists would be able to tell when the evidence produced by experiments and controlled observations made their hypotheses more reliable. In this way his theory about the proper way to evaluate scientific hypotheses was slanted towards the purpose for which such hypotheses were worth having.

If the aim of scientific enquiry is to give us power over Nature, we cannot do so without some way of appraising the evidential justification for relying on a given scientific hypothesis. If we go up in a new kind of plane, or take a new kind of medicine, we want there to be adequate test-results to show that it is reasonable to rely on it. Popperian science on the other hand, cuts itself off from technological objectives, because its epistemology rejects inductive



Francis Bacon



Sir Karl Popper

reasoning. There is no way that a Popperian can adopt a Baconian conception of scientific purpose without at the same time giving up his evaluation of hypotheses by their unfalsified informativeness and adopting instead some criterion of evidentially-based reliability. Not that a Baconian logic despises informativeness or explanatory potential. Just the opposite. But it does not measure this by mathematical improbability, and it does not identify unfalsified informativeness with reliability.

You would not wish to trust your life in a plane, or a medicine, which had been made in accordance with the boldest conjectures that have hitherto resisted falsification. Nor, perhaps, is that the kind of science which you could willingly pay heavy taxes to sustain.

My argument here is not that Popper has wholly misrepresented the nature of actual scientists' reasoning. It could be that even before reading Popper's writings some scientists have actually applied Popperian criteria of appraisal to their hypotheses. Others in doubt think that it is reasonable to rely on them. But if we want to see the pursuit of scientific truth and of intellectual power over nature as one and the same objective.

It follows that our conception of the knowledge that science seeks should be structured by appropriate criteria of evidentially-based reliability. If we want scientists to adopt a Popperian philosophy, an inductive epistemology, and a preference for explanatory

theories that generate novel and subsequently confirmed predictions. Nevertheless, Baconian appraisals of reliability, not Popperian appraisals of unfalsified informativeness, are what most communities have sought, and still need, from their scientists. In relation to the hypotheses that the latter put forward, the crucial Baconian requirement is just that we should know how reliable are the predictions that issue from a scientific theory. Then the theory can at least in principle be put to work.

Nor am I arguing that there is anything at all unworthy in individual scientists being motivated by intellectual curiosity or even personal ambition. The claim is rather that the social justification of the enterprise has to lie elsewhere. The overall, long-term aim of scientific research has to be seen as human power over Nature, or, if that metaphor is now unacceptable in environmentalists, then at least the aim must be to learn how we can ally ourselves with Nature.

It follows that our conception of the knowledge that science seeks should be structured by appropriate criteria of evidentially-based reliability. If we want scientists to adopt a Popperian philosophy, an inductive epistemology, and a preference for explanatory

ledge will become influential and the Baconian objective will lose much of its guiding force.

Two final points. First, it may well be said that Bacon's (or J. S. Mill's) inductive logic is altogether too coarse for modern purposes, and too mixed up with idiosyncratic ideas about the current order of procedure in scientific investigation. After all, modern science was very young indeed when Bacon wrote, so there was very little experience in constraining its analyses. But in recent years the underlying principles of Baconian logic have shown themselves capable of development up to a quite sophisticated level, and Bacon's logic—not his heuristic—is all that can be counted on here. So philosophy can certainly offer an adequately systematic alternative to the Popperian criterion of evaluation for scientific hypotheses.

Secondly, perhaps some people may think that Popperian science is science as Popperians conceive it—a respectable social ideal. "Popperian science is not to be justified", we may be told, "by its being an activity that satisfies the intellectual curiosities of those individuals who engage in it, but rather by its being so grand a collective product of human curiosity in general. It deserves the support of society at large in much the same way as great art or great literature does."

But then we should need two kinds of science—Popperian science for intellectual glory and Baconian science to help us in our dealings with nature—and it is difficult enough for society in afford even one kind. Moreover, Baconian science can serve both purposes. Bacon himself pointed out that having a general power over nature is necessarily more valuable than any particular exercise of that power, and also that the utility of scientific knowledge is a pledge of its veracity. So a Baconian scientist, unlike a Popperian, can see the pursuit of scientific truth and of intellectual power over nature as one and the same objective.

The author is practising in philosophy at Queen's College, Oxford.

Being second is just no good at all...

... is the title of the Yorkshire Television networked programme celebrating the 1977/78 Trident Television Award for Communication in Science.

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Prediction, through computer-based gas flow analysis, of the performance of small internal combustion engines. The process makes it possible to build engines that are cheaper, more efficient and quieter than earlier methods allowed.

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Trident Television Award for Communication in Science 1977/78
In conjunction with the British Association for the Advancement of Science

Labour's Carlylean hero

Keir Hardie: the making of a socialist
by Fred Reid
Croom Helm, £7.95
ISBN 0 85664 624 5

In recent years hagiography has been giving way to historical objectivity in interpretations of the life of James Keir Hardie, notably in the biographies by Morgan and McLennan, but he still remains something of an enigma, especially in his early career, partly through lack of evidence and partly because of the gyrations in his political views and behaviour.

Fred Reid, lecturer in history at Warwick University, concentrates on Hardie's formative years—his childhood, adolescence and early career in trade unionism, journalism and politics, up to his membership of Parliament in 1892 which ended with the crushing electoral defeat of 1895. By analysing all the available contemporary evidence for these years, he seeks to achieve "an understanding of the complex process by which Hardie's personality (both private and political) was formed", removing the "veil of myth and obscurity" with which the "early biographers shrouded the origins of the legendary hero", and at the same time providing a much fuller account of Hardie's early life than is available in the more recent biographies. The subtitle of the book indicates the author's main theme, "the making of a socialist", in which he differs from others who have studied the depth and extent of Hardie's socialist convictions, by comparison with his radical or progressive class-collaborationist "labourism". Indeed, the turning-point in Hardie's life is portrayed as a sudden "conversion" to socialism in 1887, almost like the light that struck Paul on the road to Damascus.

While there will still be serious doubts about this socialist enlightenment, the author's general interpretation of the formative influences in Hardie's early life carries conviction: the subtlest of illegitimacy, spurring him to efforts at elevating his social status (Hardie liked to imagine his father with the bourgeois respectability of a minor); the poverty and hardship of his early family and working life in Lanarkshire coal-mining, producing a sense of class-exploitation; the rural environment of many of the villages, creating a backward-looking love of the countryside and dislike of urban industrialism; the labourerist-mercantile traditions of skilled crafts, encouraging a sense of independence and differentiation from the lower working classes; his self-improvement, evangelical religious involvement, a by-product of temperance struggles, with emphasis on self-help, thrift and morality, combined with critical condemnation of the lower masses and influence of Thomas Carlyle's writings, with emphasis on the role of popular (though undemocratic) heroes, firing Hardie's notions of charismatic leadership and contributing towards his ambivalent class attitudes.

All these influences are shown to have produced a complex, even unoriginal personality, but they can be fitted into a more straightforward assessment of Hardie's motivations and changes of course in his early career. The most outstanding feature of almost all working-class leaders in the nineteenth century, as now, is their desire to escape from the working class and to achieve something like bourgeois status and respectability, while still basing their power and influence on leadership of the masses. Emphasis on class solidarity masks their main motivation, which like that of most other people is basically self-interest. If Hardie's main concern is seen as the career advancement of James Keir Hardie, then most of his other views almost inexplicably twist and turn to become intelligible.

The main routes of escape from working-class drudgery (before modern higher education) were trade unionism, journalism and politics and in these ways Hardie soon ceased to be a working miner. As Reid says, a devoted follower



"The Labour Leader" as portrayed by a contemporary cartoonist.

of Alexander McDonald, leader of the Miners' Association, but a believer in class collaboration, who had achieved comfortable economic independence and became one of the first two working-class MPs in 1874.

After the failure of Scottish miners' strikes in that year, Hardie became deeply involved in class-collaborationist self-help, evangelism and temperance activities, developing an ambivalent view of class leadership, but this experience in class leadership enabled him to become secretary of his local Hamilton district union, as a testinal disciple of McDonald. Then in the following year, after being dismissed from work for his trade-union activities, he got himself appointed paid agent for that district in a new Lanarkshire miners' union. Under rank-and-file pressure, there was a prolonged strike against wages reductions in 1879-80, in which, however, Hardie's ambivalence was clearly apparent. After his collapse, therefore, he was at first became secretary of the miners' county association, but when they could not pay his full salary he got himself a reasonably safe lower middle-class position as the local (Cumnock) editor and correspondent for the *Ardrossan and Saltcoats Herald*, resigning his union post.

In this role, until 1886, Hardie's social position became more strongly marked by an ambiguity which "remained characteristic of him throughout his life and is the key to the ambiguities of his political outlook and actions. He wanted to be the spokesman of the class, but he was resolved not to live among the communities of his class, sharing its hardships and oppressions." He became thoroughly class-collaborationist, involved in Congregationalist preaching, temperance, and good works for the poor, advising moderation in strikes, and adopting a condescending attitude to the masses; in politics he was a staunch Liberal Gladstonian, putting temperance, self-help, cooperation, and moral

independent Labour candidate in 1888 (though probably deriving some of his electoral funds from Conservative agents).

He finished bottom of the poll, however, and the SLP also proved disappointing in his political ambitions. Disregard as a broad-based alliance of trade unionists, radicals and socialists, with a progressive labourist programme, it was given a serious challenge to the Liberal Party in Scotland.

Like McDonald before him, therefore, Hardie "had no book to England for a route of entry into the House of Commons". Through his London contacts, he was invited in 1891 to become a candidate for West Ham South. Resigning his secretaryship of the Ayrshire miners' union, he eventually won this seat in 1892 with a broad appeal to the temperance and non-conformist as well as trade union, radical and socialist voters. He now sought through his parliamentary membership and his amicable relationship with the revived *Labour Leader*, as well as through the TUC (though he failed to get himself elected as secretary of its parliamentary committee), to create a new political party, in the establishment of which he played a leading role and of which he became president; indeed, he once qualified himself as "Labour's Carlylean hero", the "great leader" of the masses.

Despite his swing towards independent labourism and socialism, however, "he remained encapsulated in a middle-class life style... remote from the hardships and sacrifices of the poor", for whom he expressed compassionate consideration, proposing to regulate "farm colonies" for the unemployed, while building for himself, still capitalistic, a large country house at Old Cumnock (like later-day Labour leaders with their rural mansions, he had a holiday villa). Hardie had little sympathy, in fact, in mitigating financial contributions from middle-class sympathisers to support of his own political position, his paper and the ILP, which he sought to dominate. His financial and political position, however, at a time of mass unemployment and radicalism, and his personal popularity, enabled him to become secretary of the revived Ayrshire miners' union in 1896, and then of the Scottish Miners' Federation.

His links with the *Ardrossan and Saltcoats Herald* became increasingly tenuous; he finally resigned in 1890, and he launched into independent labour journalism with the *Labour Leader* in 1891. The defeat in 1886 convinced him that the Liberal Party could not really be a vehicle for labour measures or for his own advancement. So he jumped at the opportunity of becoming secretary of the revived Ayrshire miners' union in 1896, and then of the Scottish Miners' Federation.

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Not surprisingly, Hardie has long been an outcast to those who would like to change him as a selfless champion of working-class aspirations. While his proletarian upbringing certainly produced in him strong feelings of class exploitation and class solidarity, it also imbued him with an even stronger sense of labourerist-mercantile superiority and self-centred ambition to escape from the working class and to achieve personal status and power, through leadership of that inferior class, which might be tenuous, but which he regarded as crusading idealism, though individuals not for their own ends as well as those of the class they led or manipulated, and who are often thereafter (as Hardie was) in bitter personal rivalry with other labour leaders.

This book provides the basis for a more lifelike assessment of perhaps the most saintly figure in Labour's hagiography.

A. E. Musson

Town life

English Towns 1500-1700
by John H. Munro
Oxford, £1.00
ISBN 0 203 61721 6

This thorough and comprehensive study of early English towns is a valuable addition to the growing literature on the pre-industrial city. The author knows his way around the period, and his bibliography notes alone would justify any recommendation of the book.

His account of the major, though incomplete, sources of urban growth—household expansion, rural depopulation, parish registers, wills, manorial and indentured labour—is largely helpful.

The work is largely devoted to the author's own definition of the town, and he gives more prominence to other urban historians, all of whom are mentioned somewhere in the text, than to his own doubts on the East Anglian towns, as well as the last chapters on the original material in the book. The book is a valuable study of the town, particularly in the visual aspects of the town, which is a pity, as the author has assembled a wealth of comparative material.

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The author combines and interprets the work of many scholars in a disciplined and lucid manner, and he rightly concludes that generalisations are impossible, given the infinite variations between different towns of the period. Few historians would dispute his thesis that the town, rather than growth, was the principal characteristic of pre-industrial towns, and they could concur in his rejection of abstract structural models of the city, favoured by social scientists. But the discipline of urban definitions is surely and the book is fundamentally flawed by its own standards.

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Richard Grassby

Cambridge University Press has published at £4.50 a bibliography of books on the history of the town in England 1554-1700, compiled by Beryl Wilkison for the *Cambridge Studies in English* series. The book covers all aspects of the town, from its economic, cultural and religious life, to its social and political life, and its role in the development of the modern city.

Close-up on cells

Structure and Function of Cells
by Colin R. Hopkins
Oxford, £3.50
ISBN 0 2216 4775 8

This latest book on the structure and function of cells is aimed at university students, particularly those reading courses in biological sciences. As such it is a highly competitive market since there are already at least a dozen well established texts in this area. The excellent text by de Robertis, published by de Robertis, makes this book a little different from its competitors. It is a book that is easy to read, and it is a book that is easy to use. It is a book that is easy to read, and it is a book that is easy to use.

The first part of the book is concerned with the techniques that are used to study the structure of the cell. A range of microscopic techniques are described and methods of preparation are explained. There are also brief sections on the use of analytical procedures including cytochemical, immunocytochemical, autoradiographical, freeze culture and cell fractionation techniques.

The second part of the book deals with the nature, form and function of cell components and contains chapters on the plasma membrane, the nucleus, intracellular compartments and the cytoplasmic matrix. The structural aspects of the plasma membrane concentrate on the fluid mosaic model of Singer and Nicolson and on the various functions that are considered include signal reception, role in malignancy, transport and cell attachment. The chapter on the nucleus begins with a brief description of the prokaryotic system and then goes on to describe the regulation of nuclear activity and gene expression in eukaryotes. The nucleus and the cytoplasmic events that occur during protein synthesis. The intracellular compartments that are involved in the regulation of the nuclear system and the mitochondrion. The final chapter is mainly concerned with microfilaments and their role in muscle contraction, cell locomotion and the cell periphery and microtubules and their function in the cell and during mitosis.

Because of the manner in which the book has been written all of the topics are dealt with rather superficially but fortunately each topic is beautifully illustrated with first-class micrographs and these are described in great detail. For

most mathematicians who see mathematics as a collection of rules and small fragments of set theory, which it is never necessary to mention types. One attempt to get around this difficulty is to use the "where power" construction, and the approach is in Lattau's original book, but the present book is much fuller working out of this approach.

From the advanced mathematician's point of view this is very satisfactory, since, if one regards the axiom of choice as both true and in a generalized sense constructive, the method is itself a constructive one.

In a sense rather more than is needed is being assumed; as Machover and Hirschfeld showed in their lecture notes volume, the essential and from logic is the compactness theorem in the first order predicate calculus (first order, rather than Robinson's original more complex formulation, because one can rewrite all that is needed in a first order language whose variables range over sets or points). And the compactness theorem does not assume the axiom of choice, but only the axiom that every non-trivial Boolean ideal of a Boolean algebra can be extended to a maximal ideal. Since this follows from the statement that the topological product of any number of copies of a discrete two-element space is compact, we are dealing with a disguised form of a special case of Tychonoff's theorem.

But the ultra-power construction has the great advantage of getting the logical considerations out of the way very quickly. The approach adopted here is to give a brief and fairly informal (though actually very careful) introduction in which infinitesimals are introduced in the rational field by the ultra-power construction. This is used to help the mathematical reader through the next two chapters in which the logical apparatus is set up, and there are then two chapters on the foundations of the calculus (differentiation and integration). This first part would be suitable for mathematicians, undergraduates, at least by the third year. The second half of the book is more specialized. Two chapters, set up more logical apparatus, and the remaining two apply this to functional analysis, particularly to compactification problems and Banach spaces.

C. W. Kilmister

Into infinity

Introduction to the Theory of Infinitesimals
by K. D. Stroyan and W. A. J. Luxemburg
Academic Press, £19.20
ISBN 0 12 571150 6

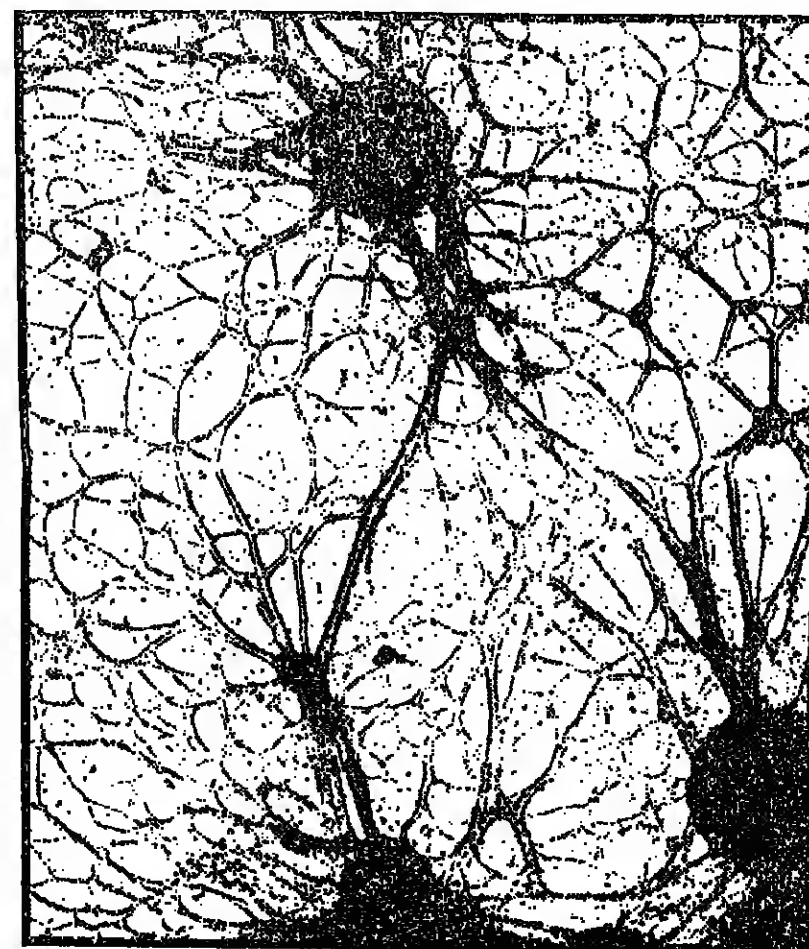
An important feature of the development of the calculus by Leibniz, which occurs only in a partially concealed form in Newton's fluxions, is the use of infinitesimals. In Leibniz's view, "they can certainly be used as ideal concepts which shorten the argument, similar to what we know as imaginary roots in algebra". Now the trouble with this view is that, as stated in detail by Leibniz, it has inherent contradictions. Two numbers which differ infinitesimally are to be identified, but not if one of them happens to be zero, and this identification has to preserve addition, which the zero condition prevents. None the less this view was the predominant one until the second half of the nineteenth century when Weierstrass (principally) formulated a much weaker way of talking which is strong enough for the calculus. It seemed as if Leibniz's view was destined to remain of the historical interest.

In the past 20 years there has been a complete reversal of the situation. In 1958 Schmieden and Robinson constructed an enlarged number system, though one that was not always possible (so that, as it were, too many numbers had been allowed in). Two years later Robinson discovered an independent way to solve Leibniz's problem completely, by using the idea of non-standard analysis, which had been implicit in logic since Cantor's 1915 result. The result is a pedagogical triumph, though immense, and it is a pity that the book is written in the form that the authors have chosen. The book is a masterpiece of clarity and order, and it is a pity that the authors have chosen to write in a style that is so formal and so technical. The book is a masterpiece of clarity and order, and it is a pity that the authors have chosen to write in a style that is so formal and so technical.

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Nerve cells in culture, magnification x 40; an illustration from Professor Hopkins's book.

D. J. Beadle

West African weather

The Climates of West Africa
by Hyacinthe Djo
Heinemann Educational, £9.00 and £4.00
ISBN 0 435 95700 1 and 95701 5

This is the first detailed account of the climates of West Africa, and it may be said at once that it has drawn very widely on published material and put it together quite admirably.

Good and detailed chapters on radiation and temperature lead into an assessment of the factors influencing evaporation and potential transpiration, and methods of measuring or estimating these, with a brief section on the water balance. The great seasonal and latitudinal variations of atmospheric moisture and rainfall are described in chapters four and five, and the latter chapter emphasizes how the seasonal migration and day to day variations in the position of the inter-tropical discontinuity (ITD) are fundamental to the understanding of weather and the climate of West Africa. Frequencies of disturbance to the south of the ITD are given, together with particular examples and associated weather.

The last chapter on wind shows several interesting synoptic examples of analysed lower tropospheric wind fields over West Africa, but only gives local examples of variations at higher levels. Of course it would require a textbook on synoptic meteorology to deal adequately with the three-dimensional systems and their associated pressure, wind and weather systems.

A chapter on regional climatic patterns applies the Köppen, Miller and Thornthwaite classifications to West Africa. Several particular classifications for Nigeria (by Fagundes and Okunola, Thornthwaite and Mather, Thornthwaite, Ayandé,

Garner, and Bullyk) all rightly concentrate on indices of moisture adequacy. The brief section in a later chapter on the use of agro-climatic classifications might have been introduced here and expanded with further examples.

The book has a very large number of excellently produced and useful diagrams and tables and has a good bibliography. This opportunity should have been taken to introduce some more material on hydro-meteorology and on micro-meteorology, and to include more on the latest research in synoptic climatology.

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A. F. Jenkinson

Acknowledging a master

Vogel's Textbook of Quantitative Inorganic Analysis (fourth edition)
revised by J. Bassett, et al
Longman, £14.00
ISBN 0 435 95700 1 and 95701 5

Some books are just too valuable to be allowed to die out by the inevitable process of becoming dated: which is, perhaps, only another way of saying that nobody can think of a method of freshening up the treatment without plagiarising on a scale that troubles even the most classic conscience. This form of pushy recognition akin to canonization is now conferred on Arthur I. Vogel with the appearance of a multi-authored revision of his *Textbook of Quantitative Inorganic Analysis*, the third edition of which appeared in 1961. A link with Vogel is retained to the person of G. L. Jeffery whose contribution to the first edition in 1939 was acknowledged by Vogel.

Modernization of treatment has meant inevitably a shift of the balance between traditional (titrimetry, gravimetry and electrochemistry) and modern (spectroscopy, gravimetry and electrochemistry) methods. They have also perpetuated a

widely-held fallacy in deleting Vogel's section on infra-red spectrometry "in view of the limited application of this technique for quantitative inorganic analysis", a claim which is emphatically untrue in relation to the new generation of ratio-recording instruments. Indeed the "chips with everything" revolution is so rapidly reducing many complex and skill-demanding analytical procedures to push-button ease that the most modern sections of this work may date the fastest.

Despite the modern flavour of this fourth edition, the primary strengths of the work remain where they always have been: in the traditional, unglamorous, and indispensable analytical methods which must constitute the court of final appeal, even in our increasingly instrument-dominated world. The authors are to be congratulated on their work, which can only perpetuate the pre-eminent place occupied by Vogel's books among analysts and teachers of the art.

David M. Adams

